

Iodine Hall Thruster Propellant Feed System for a CubeSat

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I. Abstract

THERE has been significant work recently in the development of iodine-fed Hall thrusters for in-space propulsion applications.¹ The use of iodine as a propellant provides many advantages over present xenon-gas-fed Hall thruster systems. Iodine is a solid at ambient temperature (no pressurization required) and has no special handling requirements, making it safe for secondary flight opportunities. It has exceptionally high ρI_{sp} (density times specific impulse), making it an enabling technology for small satellite near-term applications and providing system level advantages over mid-term high power electric propulsion options. Iodine provides thrust and efficiency that are comparable to xenon-fed Hall thrusters while operating in the same discharge current and voltage regime, making it possible to leverage the development of flight-qualified xenon Hall thruster power processing units for the iodine application.

Work at MSFC is presently aimed at designing, integrating, and demonstrating a flight-like iodine feed system suitable for the Hall thruster application. This effort represents a significant advancement in state-of-the-art. Though Iodine thrusters have demonstrated high performance with mission enabling potential, a flight-like feed system has never been demonstrated and iodine compatible components do not yet exist. Presented in this paper is the end-to-end integrated feed system demonstration. The system includes a propellant tank with active feedback-control heating, fill and drain interfaces, latching and proportional flow control valves (PFCV), flow resistors, and flight-like CubeSat power and control electronics. Hardware is integrated into a CubeSat-sized structure, calibrated and tested under vacuum conditions, and operated under hot-fire conditions using a Busek BHT-200 thruster designed for iodine.

Performance of the system is evaluated through accurate measurement of thrust and a calibrated mass flow rate measurement, which is a function of reservoir temperature/pressure, the flow resistors, and the setting of the PFCV. The calibration is performed using independent flow control monitoring techniques, providing an *in situ* measure of the flowrate as a function of controllable parameters. The reservoir temperature controls the iodine sublimation rate, providing propellant to the thruster by pressurizing the propellant feed system to ~ 1 -2 psi. Control of the temperature and the PFCV are used to maintain reservoir pressure and keep the thruster discharge current constant.

References

¹J. Szabo, B. Pote, S. Paintal, M. Robin, A. Hillier, R.D. Branam, and R.E. Huffman, "Performance Evaluation of an Iodine-Vapor Hall Thruster," *J. Propuls. Power*, **28**(4), 848 (2012).

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